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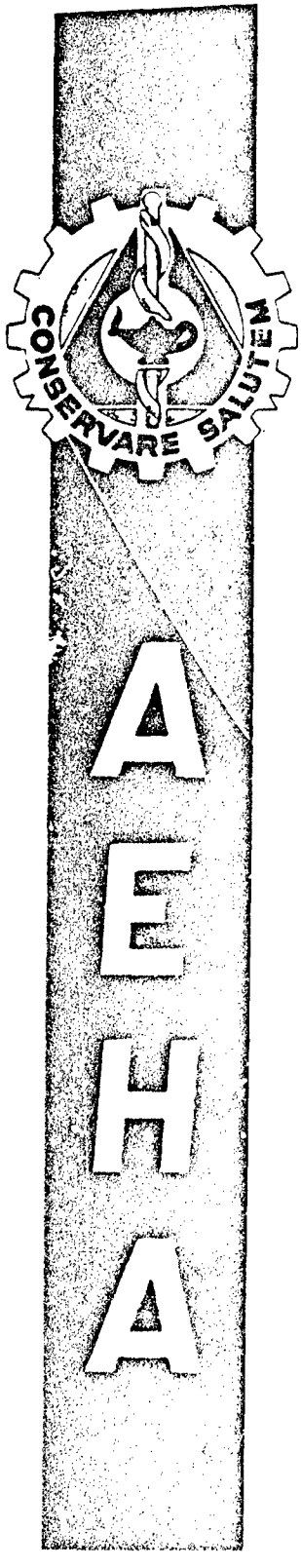

UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010-5422

90-DAY FEEDING STUDY IN RATS
WITH CHEMICAL DECONTAMINANT DS-2
TOXICOLOGICAL STUDY NO. 75-51-0682-91
SEPTEMBER 1990

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FIELD	GROUP	SUB-GROUP	DS-2, Chemical Decontaminant, Toxicity, Feeding Study, Pathology

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A 90-day feeding study was performed with rats to determine the oral toxicity of the Chemical Decontaminant DS-2. Results of this testing indicated severe toxicity at the levels tested, producers death, severe weight loss, reproductive and lung pathology and organ-to-body weight ratios. Recommendations provice for wearing of protective equipment when handling DS-2 following decontamination procedures and development of sampling strategies for determining residual levels at DS-2.

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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO ATTENTION OF

EXECUTIVE SUMMARY
90-DAY FEEDING STUDY IN RATS
WITH CHEMICAL DECONTAMINANT DS-2
TOXICOLOGICAL STUDY NO. 75-51-0682-91
SEPTEMBER 1990

1. PURPOSE. The subchronic study was designed to determine the toxic effects associated with continuous oral exposure to the chemical decontaminant DS-2 over a period of 90 days. The results provided information on target organs and bioaccumulation, and can be used to establish safety criteria for human exposure. Acute and preliminary 14-day feeding studies were conducted with a wide range of dosages to provide guidance for establishing dosing regimen for the 90-day study.

2. CONCLUSIONS. Toxic effects were noted at all levels tested in the 90-day feeding study. Lesions in the lungs and male testicular hypospermtogenesis were the primary histopathologic findings. Significant changes in testicular organ-to-body weight ratios were also noted.

3. RECOMMENDATIONS. Based on professional scientific judgement, the following recommendations are made. Require all personnel with the potential for contact with DS-2 following decontamination procedures to wear protective equipment until such time as the amount of decontaminant remaining can be determined. Develop sampling strategies to determine residual amount and persistence of DS-2 and it's components following decontamination procedures.

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO
ATTENTION OF

90-DAY FEEDING STUDY IN RATS WITH CHEMICAL DECONTAMINANT DS-2 TOXICOLOGICAL STUDY NO. 75-51-0682-91 SEPTEMBER 1990

1. REFERENCES. A list of references used in this report can be found in Appendix A.

2. AUTHORITY. Letter, OTSG DASG-PSP-E, 13 April 87, subject: 90-Day Feeding Study with DS-2.

3. PURPOSE. To determine the oral toxicity of the chemical decontaminant DS-2 in rats following 90-day administration in the diet.

4. BACKGROUND.

a. These studies were performed at the request of the Office of The Surgeon General to assist in the development of an acceptable residual level of DS-2 on food-contact surfaces following decontamination procedures (Reference 1).

b. DS-2 is a highly reactive, highly polar solution, which, when mixed with water, is also extremely corrosive. A search of USAEHA central files, Medline and Toxline, and other available literature revealed no toxicity data on the chemical decontaminant DS-2. However, substantial data exists on the three components of the solution: diethylenetriamine 69-71 percent; ethylene glycol monomethylether 27-29 percent; and sodium hydroxide 2 percent. A Material Safety Data Sheet furnished by the Chemical Research and Development Center lists health effects from primary irritation to long-term toxicity such as sensitization and asthma, but are based on the toxicity of individual components of the mixture (Reference 2). Subchronic studies conducted at this Agency were designed to determine the oral toxicity of this compound in rats when mixed with their daily diet.

5. GENERAL. In accordance with the Agency SOP (Reference 3) the 14-day and subsequent 90-day feeding studies were conducted using both male and female rats. Since it was not known what residual levels of DS-2 would be found following decontamination procedures, ground food fed to the animals on this test was mixed with pure DS-2 at various concentrations. Because of the highly reactive nature of this compound, degradation began as soon as the compound was mixed with the food and continued each day. Chemical analysis of the food mixtures over time, and the mixing of fresh batches of food each week, kept the concentrations of test material as constant as possible. Since DS-2 has a strong odor, and palatability of the mixtures might limit food consumption, an additional group of test animals was added to the test. This group was fed untreated food at the same consumption rate as the high-dose group and was designated the paired control group. Skin and eye irritation screening, normally conducted on materials being evaluated, was eliminated due to the extremely caustic nature of DS-2.

6. ANIMALS. Young adult Sprague-Dawley male and female rats were used throughout this study. Females were nulliparous and non-pregnant. All were supplied by Charles River Laboratories Incorporated, Wilmington, Delaware. Upon arrival they were randomly assigned to individual cages and individually identified by toe clip. Studies were conducted in an environmentally controlled room having a 12-hour light/dark cycle.

7. MATERIALS AND METHODS.

a. Test Material. The DS-2 used in these studies is a clear liquid solution packaged in 1 1/3-quart cans manufactured by Timmerman Corporation, Gardenia, California. The Lot number used was TMA77A-001-007, FSN 6850-00-753-4827, manufactured in January 1977. As cans were opened, unused DS-2 was stored in glass stoppered bottles purged with nitrogen to prevent precipitate from forming in the solution.

b. Diet.

(1) Certified Rodent Ration (manufactured by Zeigler Bros. Inc., Gardners, Pennsylvania) was used throughout the study (Appendix B). Food was ground to a uniform consistency with a Model 4f Straub Grinding Mill (manufactured by Straub Company, Philadelphia, Pennsylvania). All food mixtures were made weekly using neat test material and mixed with a Hobart Model 1001 Food Mixer (manufactured by Hobart Corp., Troy, Ohio). Table 1 is a mean summary of weekly percentages of DS-2 recovered in the food, at 3 days following mixture. (All tables are located in Appendix C.)

(2) Food mixtures were analyzed with flame ionization gas chromatography, using the methyl cellusolve component of DS-2 as a marker.

(3) The compound mixed readily with the food, and a check of samples from various locations in each batch indicated uniform dispersion throughout. Mixtures were then placed in glass jars and sealed for storage. Calculation and mixing of food was done in accordance with the Agency SOP (Reference 4) and can be found in Toxicology Division Notebook No. 126.

(4) All animals were allowed to eat ad libitum from these mixtures for the length of the study. Water was also supplied ad libitum throughout the study.

c. Methods.

(1) An oral ALD (approximate lethal dose) was performed with 8 male and 8 female rats as an indicator for determining proper dosages for a 14-day preliminary feeding study (Reference 5).

(2) The 14-day preliminary feeding study was conducted using eight groups of six male and eight groups of six female rats, according to Agency SOP (Reference 3). Table 2 is a list of dosages for both male and female rats.

(3) The 90-day feeding study was conducted using the three highest dosages from the 14-day preliminary feeding study. Table 3 is a listing of dosages and animals utilized:

d. Specimen/Data Collection and Analysis. All data for food consumption, animal weights, and toxic signs were recorded using the Labcat® software program. Animals were weighed prior to initiation of test and weekly thereafter until termination of the test. Animals were observed for toxic signs daily. Blood and urine samples were taken at the end of the 90-day study, and organ-to-body weight ratios noted for all animals. Analysis of food consumption, body weights, clinical chemistries, toxic

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signs, and gross necropsy findings were done using the statistical package available in the LabCat program. Clinical chemistry values were obtained using the Abbott VP Super System® and analyzed statistically with another integrated portion of the LabCat software package.

8. RESULTS.

a. ALD Determination. For the ALD, DS-2 was given as a neat solution. The ALD values for male and female rats were 1,480 mg/kg and 3,333 mg/kg respectively.

b. Preliminary 14-Day Feeding Study. The 14-day study revealed no toxic signs, gross pathology, or significant changes in organ-to-body weight ratios. Since the preliminary study was designed to determine the dosages used for the 90-day study, the highest three dosage levels from the 14-day study were selected.

c. 90-Day Feeding Study.

(1) Deaths occurred at the high-dose level in both male and female rats. One female rat died at day 32, while four males died at days 34, 37, 48, and 52 respectively. Signs noted prior to death were severe emaciation and general lethargy.

(2) Significant differences in body weight between groups was noted from the onset of the study. Control groups showed normal weight gain, while all other groups showed diminished food consumption and lower weight gain. DS-2 has a strong odor and reduction in weight gain were due, in part, to unpalatability of the food mixtures. Paired control groups, which were fed at the same consumption rate as the high-dose rats, showed an identical weight gain and permitted the comparison of high-dose animals to non-treated animals with comparable food intake. Tables 4 and 5 summarize the average weekly weight gain for male and female rats throughout the study.

(3) A weekly summary of the average daily dosages received by the various groups, based on food consumption and percent DS-2 recovered in the food is found in Appendix C, Table 6.

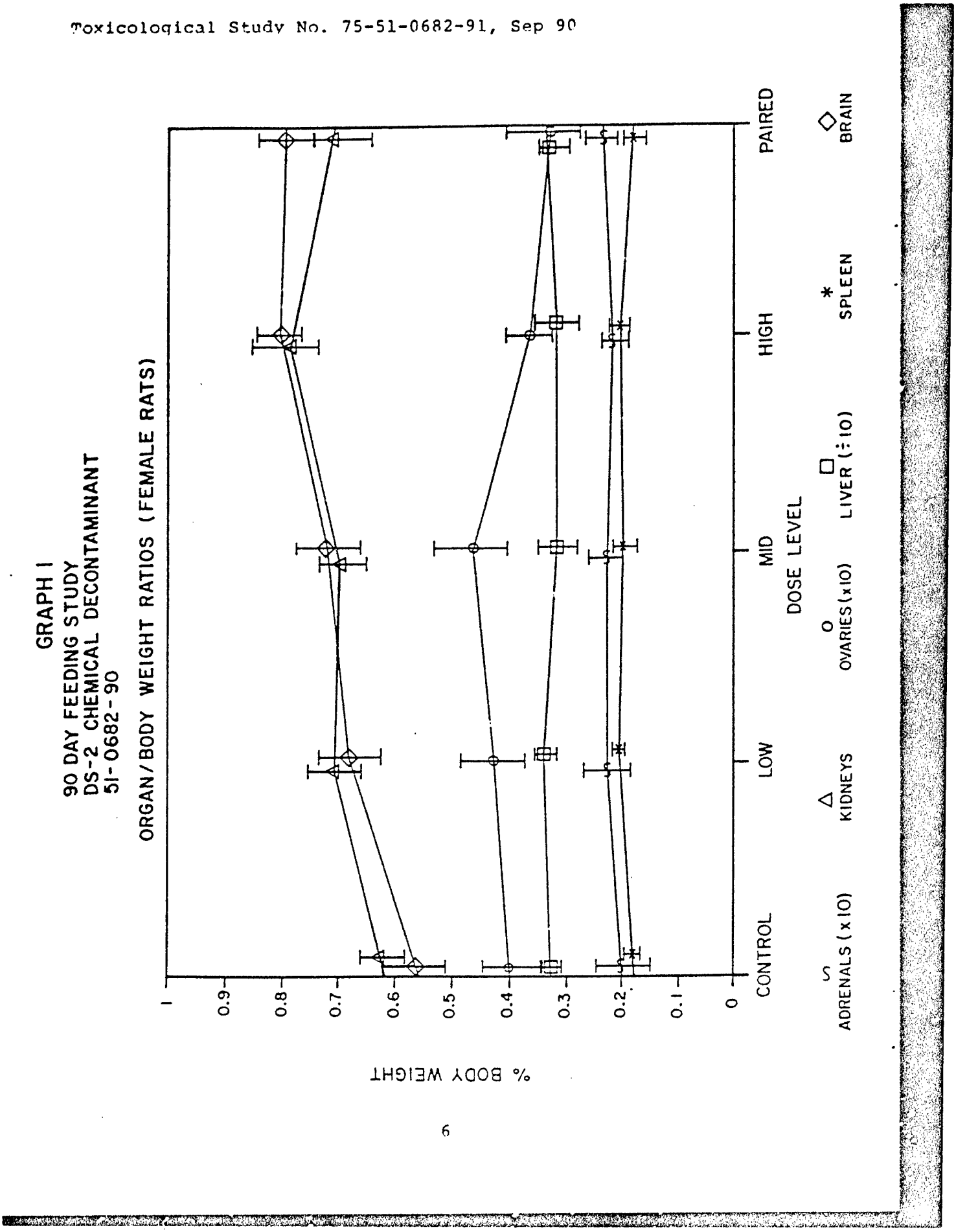
® Abbott VP Super System is a trademark of Abbott Laboratories, Diagnostics Division, P.O. Box 152020, Irving, Texas 75015.

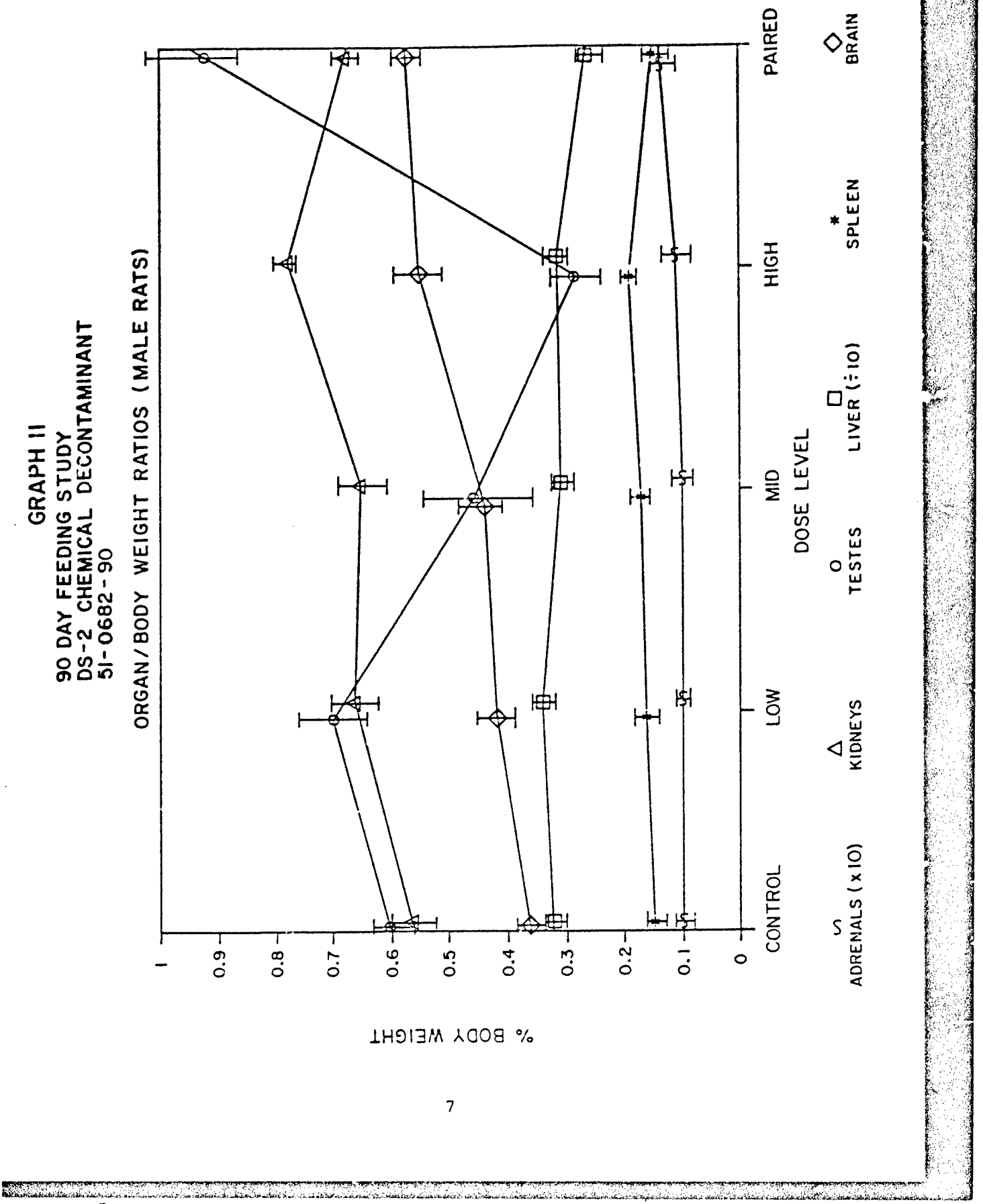
(4) Lesions which were considered to be associated with compound administration were noted in the histology of surviving male and female rats at all dosage levels. Four of six surviving males, and two of the nine surviving females in the high-dose group had pulmonary lesions consisting of chronic inflammation and atalectasis. Lesions similar to those found in the high-dose groups were found in one out of 10 of the female rats; one out of ten of the male rats at 20,000 ppm; and in one out of ten of the females, and four out of ten of the males at 10,000 ppm. In the males, there was also a high incidence of testicular hypospermato-genesis in the high (40,000 ppm) dose and the medium (20,000 ppm) dose, while the low-dose animals (10,000 ppm) showed no reproduc-tive effects (Reference 6). Organ-to-brain and organ-to-body weight ratios clearly demonstrate changes in the testicular weight of the high- and medium-dose groups. Organ-to-body and organ-to-brain weight ratios are summarized in Tables 7 and 8. Graphs 1 and 2 compare organ-to-body weight ratios. Clinical chemistry values,while generally unremarkable, showed some statistically significant changes. None of the changes appear to be compound-related but may be due to drastically reduced food consumption and were seen in both the high-dose and paired control groups. Prolonged reduction in food consumption has been shown to affect blood chemistry values (Reference 7). Significant changes in red cell count and mean cell volume were noted in the high-dose group's hematology values. A summary of hematology and blood chemistry values is shown in Tables 9 through 12.

9. DISCUSSION. Results of these studies indicate that the test material when ingested at all dose levels used in the study produced toxic effects. The use of paired control animals in this study greatly reduced the confusion associated with diminished food consumption, and allows for better interpretation of compound-related effects in the test groups. Most compounds, when mixed with food, cause reduced consumption due to palatability.

10. RECOMMENDATIONS. Based on professional scientific judgement, the following recommendation is made.

a. Require all personnel with the potential for contact with DS-2 following decontamination procedures to wear protective equipment until such time as the amount of decontaminant remaining can be determined. Significant toxicity occurred at all levels tested in this study. Due to the highly corrosive nature of this material, and the toxicity of ingested DS-2, minimal residual levels of the decontaminant could cause severe health effects.


GRAPH I
90 DAY FEEDING STUDY
DS-2 CHEMICAL DECONTAMINANT
51-0682-90
ORGAN/BODY WEIGHT RATIOS (FEMALE RATS)
% BODY WEIGHT
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CONTROL
LOW
MID
HIGH
PAIRED
DOSE LEVEL
ADRENALS (x10)
KIDNEYS
OVARIES (x10)
LIVER (÷10)
SPLEEN
BRAIN


GRAPH II
90 DAY FEEDING STUDY
DS-2 CHEMICAL DECONTAMINANT
51-0682-90
ORGAN/BODY WEIGHT RATIOS (MALE RATS)
% BODY WEIGHT
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CONTROL
LOW
MID
HIGH
PAIRED
DOSE LEVEL
ADRENALS (x10)
KIDNEYS
TESTES
LIVER (÷10)
SPLEEN
BRAIN

b. Develop sampling strategies to determine residual amount and persistence of DS-2 and it's components following decontamination procedures. Since toxicity occurred at all levels tested in this study, no acceptable level of residual DS-2 can be determined.

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EVERETT A. HAIGHT
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APPROVED:

MAURICE H. WEEKS
Chief, Toxicology Division

APPENDIX A

REFERENCES

1. Letter, OTSG DASG-PSP-E, 13 April 87, subject: 90-Day Feeding Study with DS-2.

2. Material Safety Data Sheet, DS-2, Chemical Research and Development Center, SMCRR-SFS, Aberdeen Proving Ground, Md. 21010-5423, 28 September 1984.

3. USAEHA, Toxicology Division, Standing Operating Procedure, 14-Day Range Finding and 90-Day Feeding Study in Rats.

4. USAEHA, Toxicology Division, Standing Operating Procedure, Receipt, Handling, Storage, Identification and Mixing of Test and Control Articles.

5. USAEHA, Toxicology Division, Standing Operating Procedure, Oral Approximate Lethal Dose (ALD) Determinations.

6. Termination Pathology Report, George A. Parker, D.V.M. LTD.,Veterinary Pathologist, 111-A Carpenter Drive, P.O. Box 764, Sterling, VA 22170.

7. Henry and Bernard, Clinical Diagnosis and Management by Laboratory Methods, 16th Edition.

Toxicological Study No. 75-51-0682-91, Sep 90

APPENDIX B

ANALYSIS OF FOOD USED FOR
ALL MIXTURES

35-553
CERTIFIED RODENT RATION
(ABERDEEN - 07)
NET WT. 22.7 Kg (50 Lbs.)

060590

GUARANTEED ANALYSIS

Crude Protein	Min. 20.0%
Crude Fat	Min. 4.5%
Crude Fiber	Max. 5.0%
Ash	Max. 7.0%

MANUFACTURED BY:
ZEIGLER BROS., INC.
P.O. Box 95
Gardners, PA. 17324

APPENDIX C

TABLES

TABLE 1. NOMINAL CONCENTRATION VERSUS PERCENT DS-2 RECOVERED

Predicted (amount added to food)	10,000 ppm*	20,000 ppm*	40,000 ppm*
Percent of Predicted Value recovered	57	56	52
Standard Deviation	14.5	10.6	10.2

* parts per million

TABLE 2. DOSAGES - 14-DAY STUDY

Group	No. Animals/sex	Concentration (ppm)
1	6	650
2	"	1,200
3	"	2,500
4	"	5,000
5	"	10,000
6	"	20,000
7	"	40,000
8	"	Control

TABLE 3. DOSAGES - 90-DAY FEEDING STUDY

Group	No. Animals/sex	Concentration (ppm)
1	10	Control
2	10	10,000
3	10	20,000
4	10	40,000
5	10	Paired Controls†

† Food intake of the paired controls was limited to match the diminished food consumption rate of the high dose animals. This group was started 1 week later to allow for food consumption of the high-dose group to be measured. This was done to determine true compound-related effects versus effect due merely to drastically lowered food consumption in the high-dose group.

TABLE 4. SUMMARY OF WEEKLY WEIGHT GAIN (GRAMS) (MALE RATS)

Days		Cont.	10,000 (ppm)	20,000 (ppm)	40,000 (ppm)	Paired Cont.
7	Mean	43	21†	1†	-32†	-63†
	Std. Dev.	8.1	9.7	9.6	10.9	8.9
14	Mean	30	22	16*	0†	1†
	Std. Dev.	13.4	16.9	7.0	10.7	3.7
21	Mean	34	27	20†	2†	9†
	Std. Dev.	8.5	6.9	9.4	13.2	4.6
28	Mean	31	10†	10†	-2†	1†
	Std. Dev.	6.8	10.8	11.8	20.5	4.8
35	Mean	25	30	13	-19†	-8†
	Std. Dev.	4.4	11.8	16.0	29.7	3.9
42	Mean	20	13	13	12	43†
	Std. Dev.	6.4	5.5	6.3	16.2	6.4
49	Mean	15	8	2	-5*	-13†
	Std. Dev.	7.8	10.8	24.5	14.5	5.7
56	Mean	12	10	5	3	20
	Std. Dev.	3.5	12.5	7.4	14.2	5.2
63	Mean	15	11	19	9	-33†
	Std. Dev.	3.9	3.4	11.9	9.7	3.8
70	Mean	13	4*	2†	4*	15
	Std. Dev.	5.2	9.7	8.2	8.1	4.2
77	Mean	8	13	8	4	5
	Std. Dev.	6.7	11.6	9.2	3.8	5.2
84	Mean	15	4†	8	7	13
	Std. Dev.	5.3	3.8	10.0	4.9	6.7
90	Mean	5	5	1	-6†	10
	Std. Dev.	10.2	5.0	6.7	3.5	3.9
Total Gain	Mean	266	178†	117†	29†	-1†
	Std. Dev.	40.9	34.3	30.6	16.2	19.4

* Significant from control at .05 level.
† Significant from control at .01 level.

TABLE 5. SUMMARY OF WEEKLY WEIGHT GAIN (GRAMS) (FEMALE RATS)

Days		Cont.	10,000 (ppm)	20,000 (ppm)	40,000 (ppm)	Paired Cont.
7	Mean	20	7†	-1†	-25†	-41†
	Std. Dev.	5.9	4.4	8.6	8.0	5.5
14	Mean	20	12*	8†	0†	4†
	Std. Dev.	10.8	5.9	5.7	4.9	3.9
21	Mean	13	12	12	3†	-5†
	Std. Dev.	5.7	6.7	2.3	5.8	4.8
28	Mean	11	7	5	4	6
	Std. Dev.	6.6	5.6	3.4	14.1	1.9
35	Mean	16	7*	6*	3†	10
	Std. Dev.	9.0	6.3	4.5	10.4	3.5
42	Mean	6	7	7	8	29†
	Std. Dev.	6.5	6.1	3.5	5.9	4.7
49	Mean	8	0*	3	3	-2†
	Std. Dev.	9.3	7.2	4.6	7.6	3.6
56	Mean	5	4	3	4	3
	Std. Dev.	4.8	5.0	2.7	4.8	4.6
63	Mean	7	5	5	7	0†
	Std. Dev.	5.7	3.8	2.9	4.6	3.4
70	Mean	9	3*	1†	1†	1†
	Std. Dev.	6.9	4.5	4.1	4.2	2.7
77	Mean	4	1	3	0	0
	Std. Dev.	5.8	4.9	3.4	5.0	3.7
84	Mean	1	3	1	2	-3
	Std. Dev.	10.0	10.0	10.0	9.0	10.0
90	Mean	5	2	-3	-5	4
	Std. Dev.	10.0	10.0	10.0	9.0	10.0
Total Gain	Mean	123	70†	49†	7†	5†
	Std. Dev.	35.7	16.5	19.5	18.4	23.2

* Significant from control at .05 level.
† Significant from control at .01 level.

TABLE 6. DAILY DOSE (MG/KG/DAY)

Week	Male			Female		
	Low	Med	High	Low	Med	High
1	336	582	717	400	636	778
2	346	687	1004	429	822	1112
3	352	681	1140	407	778	1210
4	329	632	1072	419	762	1293
5	333	610	976	384	743	1248
6	297	619	1061	374	722	1306
7	291	559	970	330	669	1281
8	285	551	1101	347	661	1161
9	266	555	1135	340	651	1216
10	263	525	996	340	649	1119
11	256	540	985	335	641	1211
12	254	556	1088	352	681	1205
13	241	506	1047	329	604	1135
Mean	296	585	1023	368	694	1175
Std. Dev.	±39	±57	±109	±36	±65	±135

TABLE 7. WEIGHT RATIOS - FEMALE

Percent of Body Weight	Control	Low	Mid	High	Paired
			FEMALE ORGAN TO BODY WEIGHT RATIOS		
Adrenals	0.020 ±.005	0.023 ±.004	0.023 ±.005	0.022 ±.003	0.024 ±.003
Kidneys	0.62 ±.055	0.71† ±.061	0.70† ±.054	0.80† ±.070	0.71† ±.065
Ovary	0.040 ±.011	0.043 ±.007	0.047 ±.008	0.037 ±.005	0.033 ±.009
Liver	3.33 ±.271	3.36 ±.256	3.21 ±.366	3.21 ±.468	3.42 ±.302
Spleen	0.18 ±.019	0.21† ±.025	0.20* ±.021	0.21† ±.027	0.18 ±.038
Brain	0.56 ±.074	0.68† ±.066	0.72† ±.068	0.81† ±.054	0.80† ±.060
			FEMALE ORGAN TO BRAIN WEIGHT RATIOS		
Adrenals	3.5 ±.521	3.4 ±.513	3.2 ±.576	2.7† ±.203	3.0 ±.519
Kidneys	112.3 ±18.86	104.7 ±10.21	97.5* ±9.97	98.1 ±9.77	89.1† ±7.38
Ovary	7.0 ±1.39	6.4 ±1.07	6.4 ±0.85	4.5† ±0.83	4.05† ±1.08
Liver	605 ±124.0	498* ±53.8	447† ±64.5	398† ±83.7	430† ±43.4
Spleen	31.5 ±3.39	31.0 ±4.16	27.5* ±3.70	25.4† ±3.66	23.1† ±5.59

* Significant from control at .05 level.
† Significant from control at .01 level.

TABLE 8. WEIGHT RATIOS - MALE

Percent of Body Weight	Control	Low	Mid	High	Paired
			MALE ORGAN TO BODY WEIGHT RATIOS		
Adrenals	0.01 ±.002	0.01 ±.001	0.01 ±.002	0.011 ±.003	0.014 ±.001
Kidneys	0.56 ±.054	0.66 ±.054	0.65† ±.049	0.78† ±.018	0.67† ±.025
Testes	0.6 ±.040	0.7† ±.075	0.45† ±.122	0.28† ±.052	0.94† ±.105
Liver	3.28 ±.22	3.48* ±.19	3.12 ±.24	3.17 ±.29	2.56† ±.15
Spleen	0.15 ±.012	0.16 ±.017	0.17 ±.021	0.19† ±.013	0.15 ±.018
Brain	0.36 ±.034	0.42† ±.038	0.44† ±.039	0.55† ±.049	0.57† ±.026
			MALE ORGAN TO BRAIN WEIGHT RATIOS		
Adrenals	2.73 ±.03	2.48 ±.4	2.25† ±.4	2.07† ±.4	2.43 ±.3
Kidneys	155.73 ±17.6	159.88 ±17.6	148.35 ±15.0	143.61 ±13.6	118.82† ±3.6
Testes	168.37 ±11.3	168.23 ±21.4	103.82† ±33.8	51.99† ±8.2	166.2 ±21.8
Liver	918.89 ±122.7	839 ±84.4	708.75† ±66.6	584.87† ±83.2	452.75† ±31.3
Spleen	43.24 ±5.9	39.31 ±4.7	37.42* ±3.7	35.78* ±3.9	25.97† ±2.5

* Significant from control at .05 level.
† Significant from control at .01 level.

TABLE 9. HEMATOLOGY VALUES - FEMALE

Dosage	Hematocrit (percent)	Hemoglobin (g/dL)	Red Blood Cells	Mean Cell Volume (fl)	White Blood Cells
40,000 ppm	34.9* ±1.7	14.0* ±0.8	6.25* ±0.24	55.4* ±0.73	5.81* ±1.3
20,000 ppm	37.6* ±1.5	15.2 ±1	6.57* ±0.34	56.8 ±1.9	7.96 ±2.62
10,000 ppm	38.9 ±1.9	15.4 ±0.5	6.8 ±0.29	56.5 ±0.85	7.27 ±2.95
Paired Cont.	39.9 ±2.1	16 ±0.97	6.98 ±0.38	56.7 ±1.3	6.11 ±1.9
Control	40.3 ±1.2	15.4 ±0.5	6.96 ±0.18	57.2 ±1.1	7.46 ±1.7

* Significant from control at 0.05.

TABLE 10. HEMATOLOGY VALUES - MALE

Dosage	Hematocrit (percent)	Hemoglobin (g/dL)	Red Blood Cells	Mean Cell Volume (fl)	White Blood Cells
40,000 ppm	34.5 ±3.1	14.35* ±0.94	6.24* ±0.2	55.0* ±0.6	9.08* ±1.61
20,000 ppm	38.4 ±2.5	15.42 ±0.84	6.57* ±0.3	55.6 ±0.8	10.77 ±3.9
10,000 ppm	39.1 ±2.3	15.67 ±0.52	6.8 ±0.3	55.9 ±0.9	12.79* ±2.16
Paired Cont.	40.2* ±2	16.18* ±0.52	6.98 ±0.4	56.2 ±0.6	4.07* ±0.91
Control	37.4 ±3.2	15.41 ±0.88	6.96 ±0.2	56.4 ±1.1	13.39 ±3.09

* Significant from control at 0.05.

TABLE 11. CLINICAL CHEMISTRY - FEMALE

Dosage	Alk. Phos. (i /L)	SGOT (i /L)	SGPT (i /L)	GGTP (i /L)	Glucose (mg/dL)	CA (mg/dL)	T. Bili. (mg/dL)	BUN (mg/dL)	T. Protein (g/dL)
40,000 ppm	143.5 ±54.2	65.5 ±11.1	31.4 ±7.5	2.9* ±1.9	111.6 ±16.2	11.1* ±0.4	0.5 ±0.1	18.8 ±2.5	6.5* ±0.3
20,000 ppm	148.1 ±88.9	69.7 ±14.0	31.8 ±8.8	2.3* ±0.9	117.4 ±18.8	11.3* ±0.4	0.4 ±0.1	19.8 ±1.8	7.3* ±0.5
10,000 ppm	136.4 ±45.4	74.0 ±28.5	35.2 ±7.4	4.2* ±2.2	138.1 ±42.3	11.4* ±0.4	0.4 ±0.1	15.6 ±2.7	7.6* ±0.5
Paired Cont.	293.6* ±92.6	102.7 ±78.3	38.0 ±19.0	10.6* ±1.9	125.1 ±11.2	10.6* ±0.5	0.5 ±0.1	18.9 ±3.5	7.0* ±0.4
Control	149.8 ±73.7	73.6 ±28.0	36.8 ±13.4	8.1 ±3.1	136.3 ±16.7	11.8 ±0.5	0.4 ±0.1	17.9 ±3.6	8.1 ±0.6

* Significant from control at 0.05
Alk. Phos. = Alkaline Phosphatase
SGOT = Serum Glutamic Oxaloacetic Transaminase
SGPT = Serum Glutamic Pyruvic Transaminase
GGTP = Gamma Glutamyl Transpeptidase
Glucose
CA = Calcium
T. Bili. = Total Bilirubin
BUN = Blood Urea Nitrogen
T. Protein = Total Protein

TABLE 12. CLINICAL CHEMISTRY - MALE

Dosage	Alk. Phos. (i /L)	SGOT (i /L)	SGPT (i /L)	GGTP (i /L)	Glucose (mg/dL)	CA (mg/dL)	T. Bili. (mg/dL)	BUN (mg/dL)	T. Protein (g/dL)
40,000 ppm	135.2 ±26.2	68.9 ±24.6	44.6* ±11.9	3.8* ±1.4	122.9 ±16.3	12.0 ±0.3	0.4 ±0.1	22.2 ±2.8	6.4* ±0.4
20,000 ppm	184.2 ±75.6	68.1 ±15.5	31.7 ±3.8	5.7* ±2.5	120.8 ±19.0	11.7 ±0.8	0.4* ±0.1	21.5 ±2.7	7.0* ±0.3
10,000 ppm	237.3 ±104.0	63.6 ±6.5	32.7 ±3.5	10.0* ±1.0	117.1 ±10.0	11.6 ±0.6	0.4 ±0.1	21.8 ±2.0	7.5 ±0.4
Paired Cont.	89.4 ±15.1	81.4 ±14.3	24.6* ±10.1	8.7* ±3.8	79.5* ±12.8	10.0* ±0.3	0.3* ±0.0	12.4* ±2.8	7.1* ±0.5
Control	209.6 ±79.1	107.1 ±79.8	36.4 ±5.7	14.1 ±3.3	115.9 ±15.9	11.7 ±0.6	0.5 ±0.1	19.7 ±1.8	7.6 ±0.5

* Significant from control at 0.05
Alk. Phos. = Alkaline Phosphatase
SGOT = Serum Glutamic Oxaloacetic Transaminase
SGPT = Serum Glutamic Pyruvic Transaminase
GGTP = Gamma Glutamyl Transpeptidase
Glucose
CA = Calcium
T. Bili. = Total Bilirubin
BUN = Blood Urea Nitrogen
T. Protein = Total Protein